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Numerical studies of the interaction between offshore currents and eddies in the west Caribbean Sea and transports across the Meso-American Barrier Reef and Lagoon

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The Meso-American Barrier Reef System (MBRS) in the West Caribbean Sea (WCS) stretches for over 1000 km along the coasts of Mexico, Belize, Guatemala, and Honduras; it plays an important role in the ecology, biology and economy of the region. How the MBRS is affected by the WCS dynamics is not well known and local observations are few, so a three-dimensional, terrain-following ocean model of the WCS is thus set up to study the open-ocean influence on the coastal region. The model also includes a rough representation of the Meso-American Lagoon, which is located between the reef and the shores of Belize. Satellite altimeter data are used in combination with a simple data assimilation scheme to include the three-dimensional signature of those eddies in the model. Seasonal and diagnostic calculations demonstrate the large influence that Caribbean eddies have on the flow near the MBRS, whereas the existence of either a cyclonic or an anti-cyclonic eddy near the reef can cause a reversal of the flow along the reef and very significant changes in the transports between the open ocean and the lagoon. The occurrence of satellite-tracked drifters that propagate along the reef in a direction opposite to the mean flow can now be explained by the model results. However, at some locations there is a seasonal reversal of the coastal current that is related to changes in stratification and not to eddies. Sensitivity experiments also evaluate the role of various parameters such as winds, tides and model topography. Future studies will combine new observations and more realistic numerical simulations to better understand the complicated nature of the coastal circulation in this region and to help various conservation efforts of the MBRS.